THE WEATHER AND CIRCULATION OF NOVEMBER 1954 [1]

INCLUDING A STUDY OF SOME MAJOR CIRCULATION CHANGES

HARRY F. HAWKINS, JR.

Extended Forecast Section, U. S. Weather Bureau, Washington, D. C.

THE MONTHLY MEAN CIRCULATION PATTERN

November 1954 was characterized by rather extreme storminess over northern oceanic areas. The mean contours at 700 mb. (fig. 1) show essentially a broad cyclonic sweep of westerlies from eastern Asia to the eastern Pacific. This current was stronger and farther south than normal with heights as much as 280 ft. below normal in the northeast Pacific. A similar circulation pattern prevailed at 200 mb. (fig. 2) accompanied by a belt of westerly winds with average speeds of 50 to 55 m. p. s. extending from Korea to the mid-Pacific. Cyclones which were both numerous and intense, showed a marked tendency to rendezvous in the western Gulf of Alaska (see Chart X), where sea-level pressures averaged some 8 to 11 mb. below normal in a 992-mb. mean Low (Chart XI and inset).

After traversing the eastern Pacific, the westerlies turned quite sharply in anticyclonic fashion over western North America where a stronger-than-normal ridge was located. (Fig. 1 shows heights 180 ft. above normal in Idaho.) Despite the proximity of this ridge, a weak trough maintained off the southern California coast (somewhat similar to the pattern of the preceding month [1]). Downstream a well-marked trough dominated eastern North America, although heights remained above normal through mid-latitude sections of the trough. At 200 mb. the mean westerly maximum split over central North America, with one branch going eastward through James Bay to Newfoundland, and the other going southeastward from the Dakotas to Florida and thence northeastward along the east coast to Newfoundland. The principal storm track was either through central Canada or along the Canadian-United States border (Chart X). However, a number of secondaries occurred at lower latitudes in the United States and contributed to the sharp trough over the Southeastern States.

Anticyclonic circulation prevailed over the central Atlantic (a definite change from the mid-latitude trough of October) with a well-marked mean "jet" at higher latitudes. The mean Low at sea level between southern Greenland and Iceland (Chart XI) was both intense (11 mb. below normal) and persistent throughout November, as it had also been in October. East of this zone of concentrated westerlies the contours (fig. 1) diverged markedly to the weak trough in the eastern Atlantic and a deeper trough over the central Mediterranean.

At very high latitudes the polar vortex continued stronger than average with heights some 200 ft. below normal in Baffin Bay. Below normal heights in the Arctic Basin have been a prominent feature of quite a few monthly mean maps this year [2]. It remains to be seen whether or not the current persistence of above average polar westerlies (at 700 mb.) represents a real secular trend, a temporary abnormality, or an error in the normals at high latitudes due to the scarcity of data in early years.

SOME WORLD WEATHER NOTES

The prolonged spells of stormy weather which had affected the British Isles and, to some extent, central and southern Europe (see previous articles in this series) were temporarily interrupted in November. The area of difluence over the eastern Atlantic was accompanied by some interludes of more clement conditions. On November 18 this reversal was accompanied by a heavy fog over southern areas of the British Isles which reduced visibility in some places to only 5 yards. However, a return to strong cyclonic circulation due to migratory perturbations associated with the North Atlantic westerly maximum was soon experienced. On November 26, winds of 60 m. p. h. and over delayed sailings and caused coastal flooding in southwestern counties. This was the onset of a stormy period which continued into early December and resulted in the sinking of several ships. The combination of heavy rains and wind-driven flooding furnished a fitting wet-harvest climax to a disastrous summer.

The typhoon season of 1954 was notably late in getting under way but, since its onset, typhoon activity has been both frequent and strong. While typhoons in November are far from unknown, November 1954 had more than the usual two. Indications of these occurrences may be seen in figure 1, where a 700-mb. mean Low prevailed over the northern Philippines.

Of additional interest was the first strong "Kona"

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[1] See Charts I-XV following p. 353 for analyzed climatological data for the month.

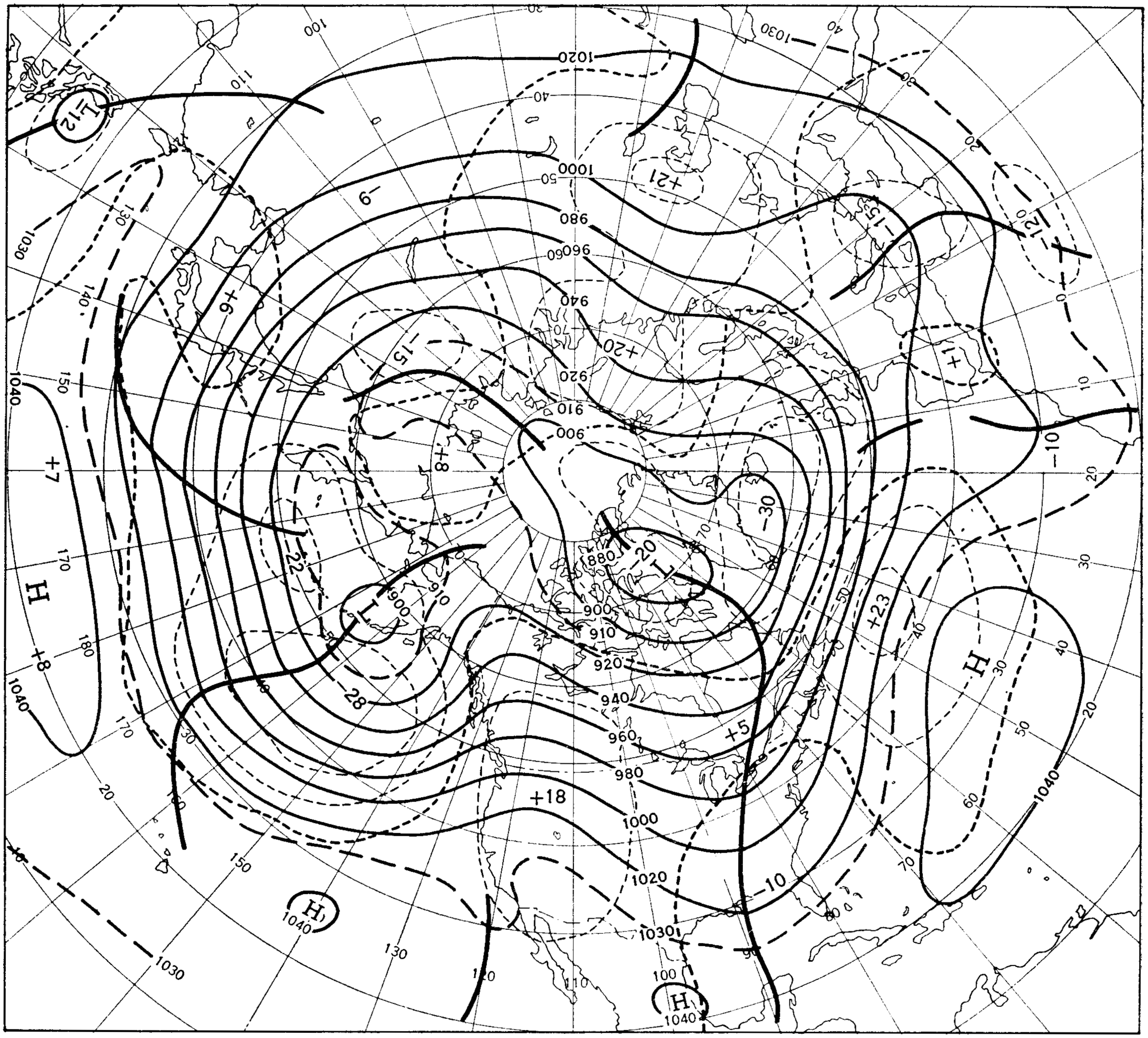

FIGURE 1.—Mean 700-mb. contours and height departures from normal (both in tens of feet) for October 30 to November 28, 1954. Strong cyclonic circulations and fast westerlies were conspicuous over the northern Atlantic and Pacific. Prevalence of ridge conditions over western and well-marked trough over eastern North America were significant features of the local circulation.

storm in the Hawaiian Islands since 1951. This disturbance gave 13.80 inches of rain at Hilo, Hawaii, from November 27 through December 1 and was associated with a major change in Pacific circulation at the end of November. The sequence of events leading to this development is discussed in more detail in the latter portion of this article.

WEATHER AND ANOMALIES OVER THE UNITED STATES

With the exceptions of central California and the southeastern United States (from central Texas through Pennsylvania and New Jersey) the country was unseasonably warm during November (Chart I–B). The center of undue warmth was located over the Northern Plains with temperatures as much as 12° F. above normal in eastern Montana. This mild regime may be attributed to the strong southwesterly flow of marine air which entered the continent between northern California and northern British Columbia. Monthly mean thicknesses (1000–700 mb.) were above normal over the whole continent except the southeastern United States and northeastern Canada (chart not shown). In general these characteristics were not atypical of the regime usually associated with a Great

Basin High and stronger-than-normal westerlies to its north.

In such cases above normal temperatures frequently extend to the New England coast. And, as in this month, cold cP outbreaks are rather infrequent and most apt to affect only eastern United States areas. The surges of maritime air and resulting Basin Highs are indicated on Chart IX, as are the glancing cP Highs (exception, the early period outbreak over the Plains). As might be anticipated this modified maritime air usually produces below normal temperatures only in lower latitudes at this season. Thus the southeastern United States, under the upper-level trough, was quite consistently the coldest area in the Nation relative to normal.

Basin High patterns frequently show near to below normal temperatures in or near the high pressure centers. These result from an excess of outgoing radiation, accompanied by low minima and, with high albedo when snow cover is extensive, depressed maxima. Occasionally a similar effect is observed when a radiation fog is slow to burn off and sharply reduces the maxima although the minima may remain above normal. The characteristic "radiation pocket" has been rather uncommon in recent years, and the anomaly of this November, showing below normal temperatures in California, appears to be associated with this latter type of mechanism. Below normal temperatures did not occur in the mean High center (in Idaho) but rather in the protected terrain of the Central Valley of California where air movement was quite slow. Fogs were frequent and slow in burning off. Once the air was chilled, lack of air movement permitted the regime to be almost self-propagating. When destroyed, the situation returned again as the preferred pattern again became effective. In a local extension of this stagnant regime during November fog, smog, and haze were particularly offensive in the southern California coastal region from the 24th to the 28th. Most of some 2,000 traffic accidents reported during this 5-day period were attributed to the poor visibility.

Despite the ridge aloft over the Great Basin, precipitation was adequate over the Far West. In the north, the west-southwesterly flow of marine air gave the coastal States moderate to heavy amounts. Precipitation of note also occurred in California, Nevada, and Colorado due to cyclonic activity associated with the California coastal trough. However, in widespread areas east of the ridge, where the dry northwesterly flow was also subject to foehn influence, precipitation was significantly less than normal.

From Arizona east-northeastward across the Panhandle through Indiana precipitation was less than half of normal. Statewide averages showed these percentages: Arizona, 13; New Mexico, 15; Oklahoma, 14; Kansas, 1; Nebraska, 14; Iowa, 15; Missouri, 34; Arkansas, 37; Illinois and Indiana, each 49. Thus the drought (see previous articles) continued unbroken in the Central Plains.

In the East, on the other hand, additional recovery

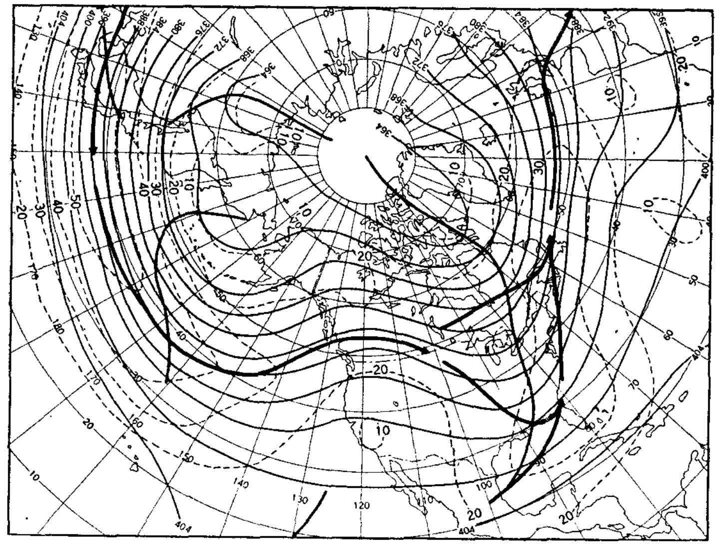

FIGURE 2.—Mean 200-mb. contours (in hundreds of feet) and isotachs (dashed, in meters per second) for October 30 to November 28, 1954. Solid arrows indicate axes of monthly "mean jet stream". Well-marked Pacific maximum speeds and the split jet over central North America are interesting features although the pattern is essentially similar to figure 1.

from summer rainfall deficiencies was made. Under and east of the trough aloft precipitation ranged from about 75 percent of normal to 150 percent of the normal amounts over and east of the Appalachians. In addition Alabama and Mississippi received respectively, 75 and 86 percent of their normal November precipitation. As an oddity, Key West, Fla., received 18.33 inches of precipitation in 24 hours on the 13th, due apparently to easterly wave instability in combination with a weak frontal discontinuity.

In general, the anomalies of temperature and precipitation over the United States showed a marked tendency to reverse from those observed in October. This has been a frequent phenomenon in recent years [3] but in this case the reversal was accompanied by changes in the hemispheric wave patterns mainly at middle and not at high latitudes. Nevertheless there were a series of changes which took place in the latter half of November and early December which were noteworthy in themselves as well as in other contexts [4]. The last part of this article is concerned with these changes and an adjacent article by Hughes and Foster discusses in detail some of these changes as they related to tropopause behavior over western United States and Canada.

CIRCULATION CHANGES OF LATTER NOVEMBER THROUGH EARLY DECEMBER—INCLUDING SOME CONCURRENT SOLAR DATA

Between the periods November 13–17 and December 4–8 there occurred a series of marked changes in the hemispheric circulation pattern involving sharp reversals in the phase and/or the amplitude of the wave pattern. In one case the change in height at 700 mb. was of a magnitude unequaled in the available record. While the transitions appear to be to some extent explainable with existing

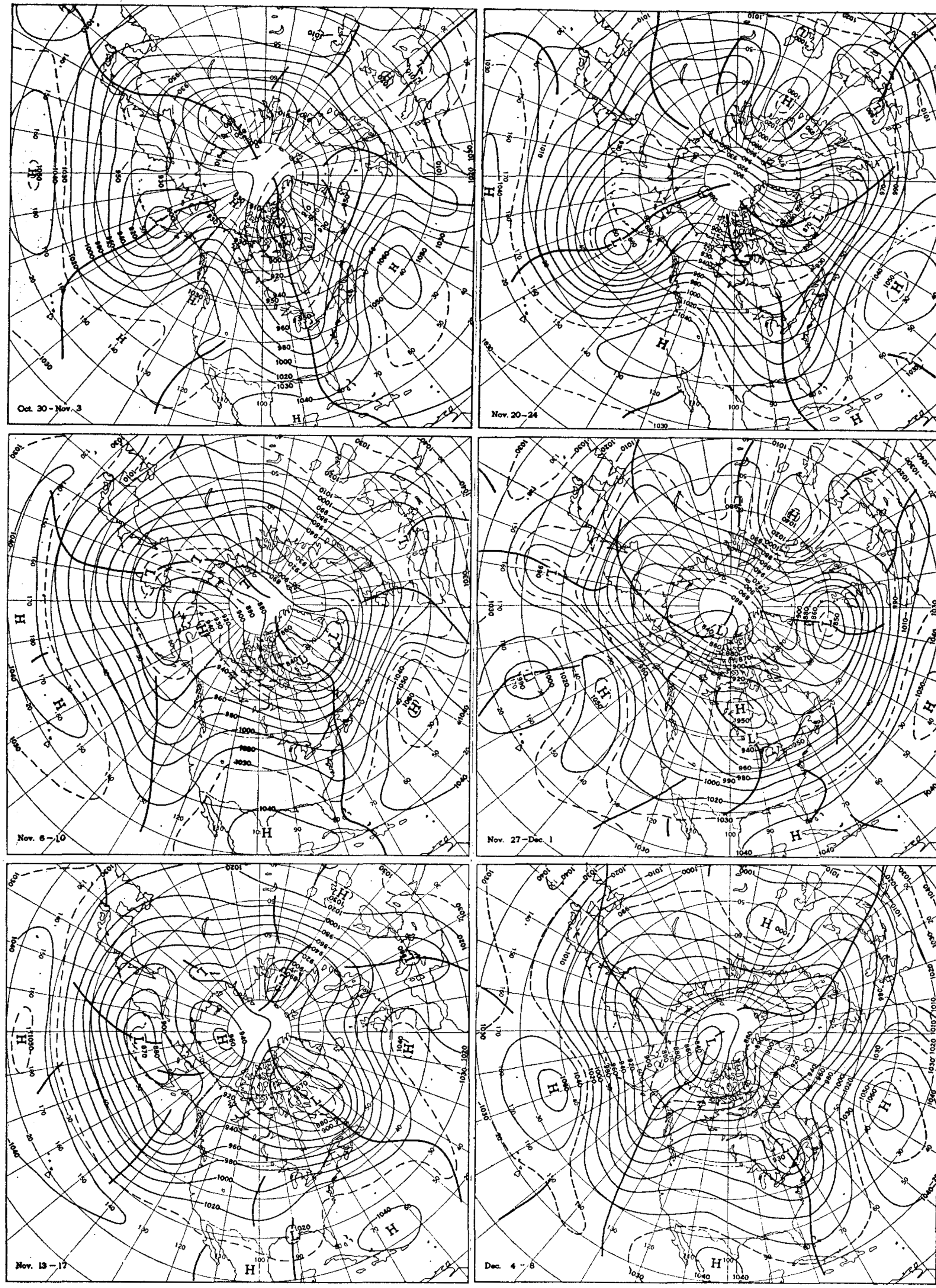

FIGURE 3.—Five-day mean contours at 700 mb. (in tens of feet) for periods one week apart, October 30–December 8, 1954. Note changes which appeared near Novaya Zemlya (Nov. 20–24), over the Central Pacific (Nov. 27–Dec. 1), and over the Atlantic (Dec. 4–8).

knowledge of synoptic meteorology, the rationalization is far from simple and satisfactory. Apparently a barotropic mechanism alone is insufficient to explain the evolutions, and application of more complex systems without high speed computors is not practicable at present. In view of recent attempts to relate solar influences to meteorological events, an inspection of the variations in a few of the contemporary solar indices has been made. While some appreciable solar variations are discernible, their influence on the meteorological events which transpired is highly questionable.

The following discussion of the problem is divided into three parts: A. Description of early November circulation and its evolution, B. Description of the circulation changes with an attempted rationalization, and C. Solar variations. The basic data showing the changes of interest are given in figures 3 and 4, the 5-day mean contour patterns at 700 mb. and their departure from normal, one week apart, (no overlapping data) from October 30 through December 8.

A. EARLY NOVEMBER CIRCULATION AND EVOLUTION

The following transitions may be pointed out:

1. A fast, small-amplitude westerly pattern over the Pacific gradually intensified with the westerlies sharply peaked and south of their normal position by November 13–17. The mean departure from normal clearly indicates the abnormality inherent in this pattern.

2. Over North America there occurred a gradual relaxation of the large-amplitude ridge-trough conditions of Oct. 30–Nov. 3, as the westerlies of the Pacific gradually spread their influence downstream and lower latitude elements of the wave pattern moved eastward.

3. A somewhat similar relaxation and eastward displacement of the ridge-trough system was noted over the Atlantic during the same time (Oct. 30–Nov. 10).

4. Asia was the site of moderate westerly flow (50°–60° N.) with the development of a deep vortex near Novaya Zemlya, following ridge intensification in the eastern Atlantic (Nov. 6–10). In addition, there occurred a slow retrogression and marked buildup of a warm blocking High north of the Bering Straits. Initially this could hardly be classified as a blocking phenomenon. The marked intensification of the High, which strengthened quite steadily from the 8th through the 13th, resulted in a significant block and contributed to the suppression of the Pacific westerlies noted above.

B. MAJOR CIRCULATION CHANGES OF LATE NOVEMBER–EARLY DECEMBER

In the course of the succeeding three weeks (following Nov. 13–17) some very pronounced changes in the hemispheric pattern took place.

1. First week.—During November 20–24 blocking was centered south of Novaya Zemlya, a marked reversal in circulation from the preceding week. This block appeared to be a merger of the Bering Sea High and the Atlantic ridge, with the latter apparently making the major contribution. However, retrogression of the Bering Sea High permitted northerly winds from the Arctic Basin to pour cold air into the Aleutian Low, thus further intensifying an already strong mid-latitude vortex. From this area (Central Pacific) a straightforward dispersion of energy downstream would seem to account for the amplified United States-Atlantic wave pattern. Height anomalies for November 20–24 are shown in figure 4 and the changes in mean heights from the period November 13–17 are shown in figure 5. The preceding phenomena can be readily identified on these charts while the changes involved in initiation of the polar vortex are most marked in figure 5.

2. Second week.—From the period November 20-24 to November 27–December 1 the Central Pacific experienced the largest change in 5-day mean heights (one week apart in time) noted anywhere in the Northern Hemisphere since records became available in December 1947. The reversal from an 8,600-ft. Low (Nov. 20–24) to the 10,500-ft. High (Nov. 27–Dec. 1) was a complete change in phase of the wave pattern and involved height changes of over 1,860 ft. (in 5-day mean)! These were some 300 ft. larger than any previous changes of record. Rationalization of this event might follow these lines: The strong block of western Asia certainly favored trough activity well to the west of the existing central Pacific vortex. As the trough developed along the northeastern Asiatic coast, a strong High moved eastward off the coast and, supported by the new, more favorable vorticity flux from upstream, split the strong westerlies of the mid-Pacific. Cool air at low latitudes developed into an intense Kona storm which inundated parts of the Hawaiian Islands. This low-latitude disturbance in turn furnished warm air and dynamic support for the ridge to its north.

As might be anticipated, this "about face" in the Pacific was accompanied by immediate adjustments downstream. In the course of one week the warm stable ridge along the west coast of North America which had persisted for many weeks (see adjacent article) was replaced by a much colder northwesterly flow, much of it cyclonic in character. The upstream changes in the Pacific seem to answer, but to remove by one step only, the more immediate reasons for the changes over western North America.

From mid-United States through the eastern Atlantic this period (Nov. 27–Dec. 1) was marked by a flattening of the wave pattern, in part due to the cessation of any supporting vorticity flux from upstream for the previous standing-wave pattern. The result was a strong band of mid-latitude westerlies, supported by confluence over eastern North America, but perilously long and flat in terms of a subjective evaluation of their inherent stability of flow.

In figure 4, the height departure from normal for November 27–December 1 highlights the further intensification of the polar Low, the anticyclonic wedge which replaced the Pacific vortex of the previous week, and circulation abnormalities from mid-United States through the

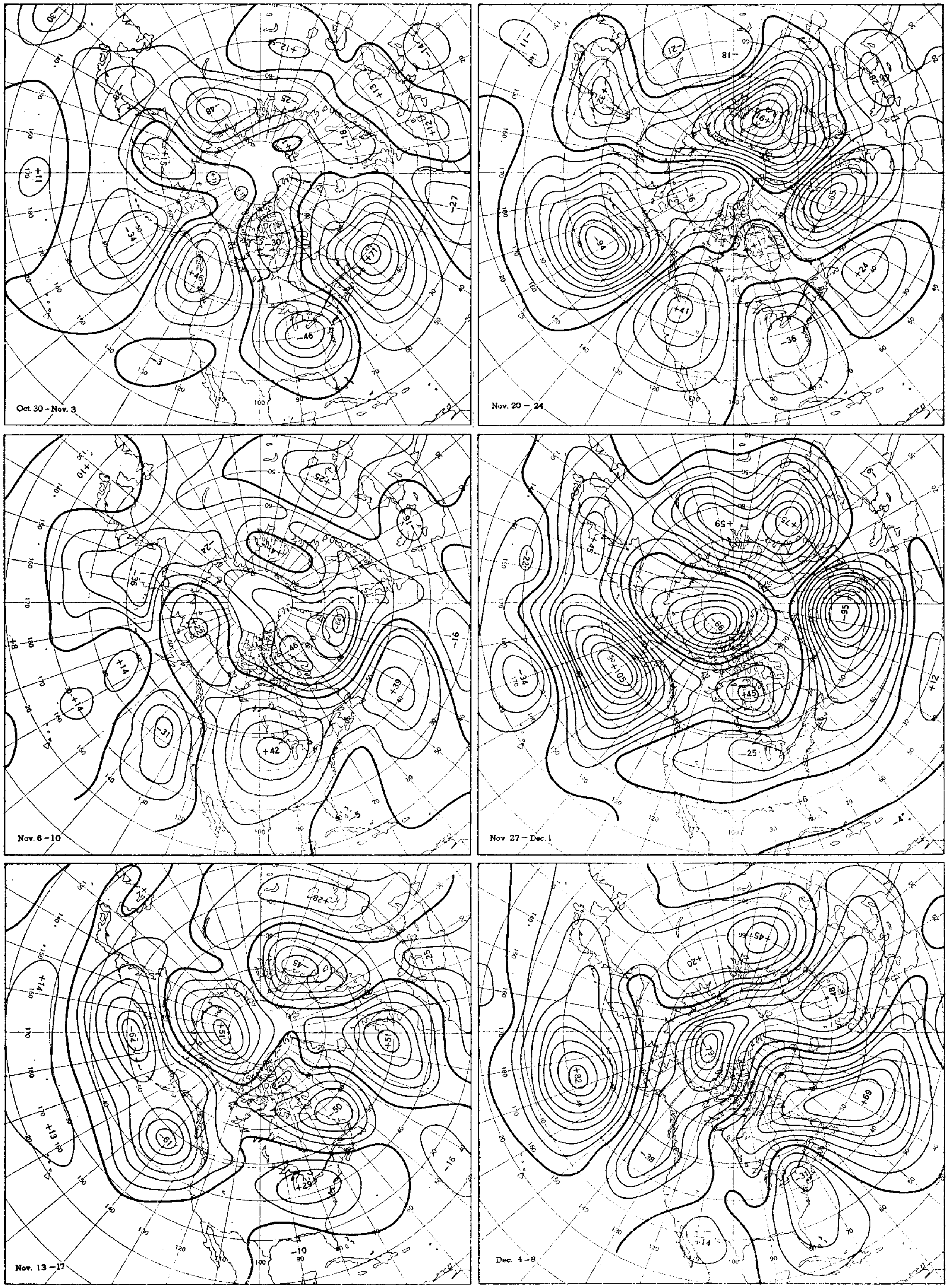

FIGURE 4.—Height departures from normal (in tens of feet) accompanying patterns shown in figure 3. From November 13 through Dec. 8 the polar vortex intensified and the westerlies were displaced northward as circulation reversals proceeded progressively from Novaya Zemlya (Nov. 20–24) through the central Pacific (Nov. 27–Dec. 1) to the Atlantic (Dec. 4–8).

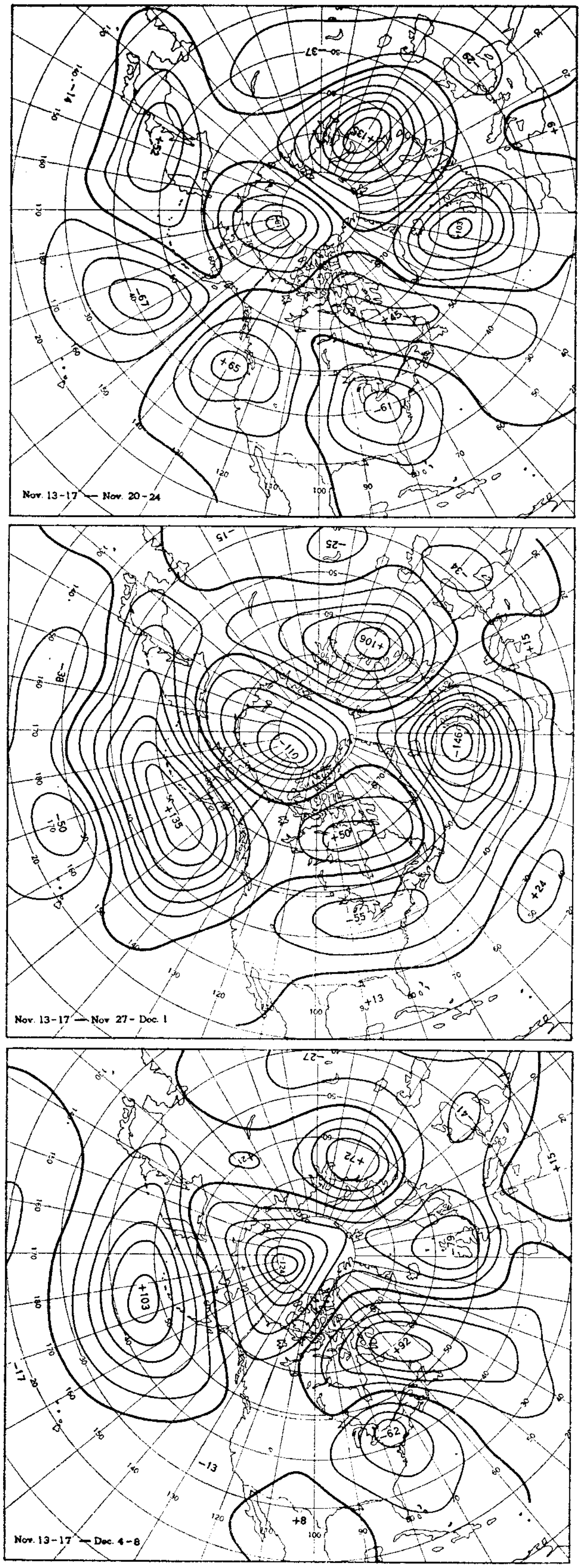

FIGURE 5.—Total height changes (in tens of feet) from the period November 13-17 to the periods November 20-24, November 27-December 1, and December 4-8, showing the progression of the major pattern readjustments and the total changes accompanying the sequence.

Atlantic which were opposite to those of the period Nov. 13-17. In figure 5 the height change between the November 13-17 and November 27-December 1 5-day means are shown on the middle map and reflect most of the features already discussed.

3. Third week.—The period December 4-8 is the final stage considered in this series. The most significant development was a sudden buckling of the Atlantic westerlies (one week height changes of over 1,200 ft.) and the partial relaxation of blocking conditions northeast of the Caspian Sea. Other features of interest include: (1) Further intensification of the Asiastic coastal trough, (2) Development of a strong trough off the west coast of North America in phase with Pacific vorticity flux, (3) Increasingly anticyclonic circulation over west-central North America as upstream features extended their influence downstream, (4) Trough intensification along the eastern coast of the United States, (5) Strong trough from southern Scandinavia southeastward, and (6) Perpetuation of the strong polar vortex. Comparison of these features with the normal state is shown in figure 4 and the changes from November 13-17 are given in figure 5.

In summation.—The block which became established over northwestern Russia during November 20-24 appears to have been out of phase with a vigorous Pacific circulation. Reactions in the Pacific were both rapid and unusually intense, with implications that more than barotropic influences were instrumental in subsequent evolution. Both North America and (even more markedly) the Atlantic underwent greater than normal fluctuations as readjustment proceeded downstream. The net change (fig. 5) was a marked intensification and contraction of the circumpolar vortex, with the major westerlies shifting northward and with cutoff or semi-cutoff vortices becoming established at middle and lower latitudes.

C. SOLAR VARIATIONS

It is expected that solar activity probably reached what will be regarded as the intercycle minimum some time between May and July 1954 [5]. In consequence, spottedness was rare, at relatively high solar latitudes, and accompanied by no sudden ionospheric disturbances. In table 1 are listed the relative sunspot numbers, the daily sums of the Cheltenham 3-hr K indices of geomagnetic disturbance, and the Mt. Wilson K_2 index (apparent area of K_2 flocculi) [6] which correlate quite highly with relative sunspot numbers. The geomagnetic character figures from Cheltenham failed to reveal any storms with 3-hour intensity greater than 5 (storms of intensity 5 occurred on the 2d and 30th). For November they appear inversely arrayed when compared to sunspot numbers.

The usual relation of K_2 index to sunspot number is apparent in this array. However, the variations in sunspot number are probably the most striking aspect of the data. The obvious question is whether such short term variations in spottedness could possibly effect, in miniature, responses similar to those longer term effects indicated by studies in this field [7, 8, 9]. Also, with what time lag might the responses be expected?

TABLE 1.—*Indices of solar activity, October 24 to December 8, 1954*

Date	Zurich provisional relative sunspot numbers	Daily sums of Cheltenham 3-hr. index of geomagnetic disturbance	Mt. Wilson K_3 index (in 1/10,000 of solar hemisphere)
1954			
Oct. 24	8	33	31
25	8	23	11
26	7	18	15
27	0	21	15
28	0	12	12
29	0	9	0
30	0	21	2
31	0	19	0
Nov. 1	0	30	10
2	0	25	14
3	0	22	14
4	0	13	20
5	0	15	20
6	7	13	25
7	8	9	19
8	7	7	
9	24	12	30
10	36	5	
11	44	12	
12	38	15	29
13	37	13	71
14	23	11	72
15	9	2	
16	7	0	51
17	7	8	36
18	7	13	30
19	7	17	33
20	0	20	27
21	0	17	27
22	0	16	0
23	0	20	0
24	0	12	0
25	0	15	14
26	0	13	5
27	0	14	9
28	0	12	8
29	0	16	9
30	0	20	10
Dec. 1	0	12	5
2	0	14	10
3	0	11	
4	0	7	14
5	0	9	14
6	0	11	
7	0	16	20
8	0	9	20

In general, no compelling correspondence was found with either the January sunspot maximum minus sunspot minimum maps of Wexler [7] or with Willett's description of general behavior expected at analogous phases in the cycle [8]. The latter may be due to the fact that this small-term cycle may have no direct counterpart in Willett's description of the long-term cycle. It is pertinent to note that a somewhat similar cycle in spottedness was also noted in October 1954 but with a less pronounced maximum (24 on Oct. 16).

This brief recital hardly exhausts the list of solar criteria, nor can the lack of similarity in reaction to those responses cited by others be taken as indicative of either the reality or unreality of atmospheric response to solar stimuli. One can only point out that, following some interesting evidences of increasing solar activity, a major block was set up in northwestern Asia. In the gross sense this type of activity was the sort of response which is expected to accompany these solar changes. However, many details of the patterns showed little or only fleeting resemblance to the more "typical" changes.

A recent paper by Namias [10] investigates an analogous problem, i. e., evaluating weather pattern evolution relative to solar activity (flares). In his case more obvious mechanisms to account for atmospheric changes were available. This comes to a very timely point. It seems to the writer that one use to which the numerically computed prognostic charts can be put is to gage the rarity or complexity of circulation changes. Presumably, with forecasts based on the current circulation models one could tell what part of the changes discussed previously were barotropic and what part baroclinic. Such numerical forecasts will at least indicate what proportion of the shorter-term changes are due to certain processes. After some experience of this nature has been accumulated one will be much better equipped to judge whether there is any necessity at all to look farther afield than extensions of the prediction models themselves in the evaluation of singular meteorological phenomena. This would not of necessity, apply to longer, more slowly impressed characteristics, gradually cumulative in nature and which may indeed be the type associated with long- rather than short-term solar influences.

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